Current Source with Indicator

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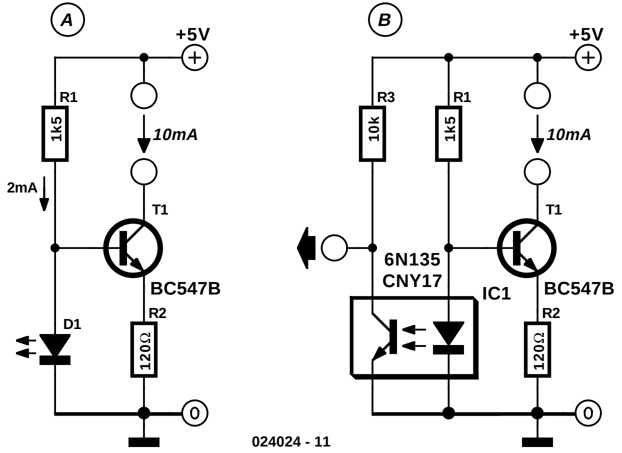
There's nothing new about a current source consisting of a transistor, a resistor and an LED to provide the reference voltage. However, what many people do not realise is that the LED provides an excellent indication of the proper operation of the circuit.

First let's review how this circuit works. The voltage drop across the LED is approximately 2 V, with practically the same temperature coefficient as that of the transistor. This means that in principle the voltage across the emitter resistor is constant, since the base–emitter voltage is constant (at least for a fixed base current, and that is normally true with a constant collector current, which is what we want to achieve). A constant voltage across a resistance yields a constant current, and up to now everything is clear.

The current through the LED is chosen to nicely illuminate it, which means 1–2 mA in the case of a high-efficiency LED. The transistor also needs a bit of current – if 200 mA flows through the current source and the transistor has a gain of 200 (a 'B' type), this is 50 µA. However, if too little current (or no current) flows through the collector of the transistor, the voltage drop over R2 will decrease. This leads to a lower emitter voltage, and the transistor will attempt to boost the emitter voltage via its base–emitter junction. As a result, the current does not flow through the LED, but instead via the base. There is thus less current left over for the LED, which will quickly become dark. This means that whenever too little current flows through the current source the LED goes out, and this is an excellent *visual* indication of the operation of the current source. An excessively low current flow can be caused by the absence of the supply voltage, a disconnected or broken cable or an excessive load resistance.



A visual indication is nice to have, but we often need a logical indication in order to allow the signal to be further processed. In this case we can replace the LED by the LED of an optocoupler. As long as the LED receives sufficient current, the built-in transistor will conduct (with the output thus being Low). As soon as the current source no longer operates properly, the LED no longer receives any current and the transistor is cut off, so the logic output goes High. The type of optocoupler used is not critical; just about any common type is acceptable.

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